

Rediscovery and new records of *Passiflora auriculata* Kunth and *P. cissana* Harms (Passifloraceae) in Brazil

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Abstract

We present here the rediscovery of *Passiflora auriculata* Kunth and *P. cissana* Harms in Maranhão state, northeastern Brazil, and new reports of occurrence of those species in Alagoas state, northeastern Brazil, and Tocantins state, northern Brazil. We provide taxonomic information, distribution maps, and conservation status of both species, thereby contributing to increasing knowledge on Passifloraceae in those states.

Keywords

Conservation status, distribution, new occurrences, taxonomy.

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Introduction

Passifloraceae *s.l.*, which is currently formed by Passifloraceae, Turneraceae, and Malesherbiaceae, is the most recent classification of the group in a phylogenetic context. This classification is accepted by most researchers since in it the family is clearly monophyletic, as revealed by combined data from DNA markers and sequences (APG IV 2016; Tokuoka 2012). The families in this clade share several morphological characters such as corona filaments, gynophore, and seed aril (Thulin et al. 2012; Tokuoka 2012).

Passifloraceae *s.s.* is mostly formed by herbaceous or woody vines with tendrils, with only few representatives

being trees or shrubs (Killip 1938). The family is composed of roughly 17 genera, which are distributed across all tropical and subtropical regions of the New and Old Worlds (Feuillet and MacDougal 2007). *Passiflora* L. is not only the largest genus in Passifloraceae *s.s.*, having approximately 570 described species with pantropical distribution (Ulmer and MacDougal 2004; Milward-de-Azevedo 2019; The Plant List 2020), but it is also the most diverse genus of the Americas (Boza et al. 2018). Approximately 150 *Passiflora* species are known to occur in Brazil, especially in the states of Amazonas, Minas Gerais, and Pará, which are the most representative ones in terms of number of species (BFG 2015; Imig et al. 2018; Lista da Flora do Brasil 2020).

Passiflora auriculata Kunth and *P. cispnana* Harms are both representatives of *Passiflora* subg. *Decaloba* (DC.) Rchb., the second largest subgenus in *Passiflora*, encompassing about 250 species that include herbaceous vines and lianas with high morphological, biogeographical, and ecological diversity (Boza et al. 2018). Brazilian species in this subgenus have linear-subulate stipules, presence or absence of ocelli on the leaf blade, small flowers (<4 cm in diameter), corona filaments with either one- or two-series, and plicate operculum (Milward-de-Azevedo et al. 2012).

We present here the rediscovery of two species of *P.* subg. *Decaloba* in Maranhão state, northeastern Brazil, and new reports of occurrence of those species in Alagoas state, northeastern Brazil, and Tocantins state, northern Brazil. We also provide descriptions, photographs, conservation status, and comments on the geographic distribution of both species.

Methods

Passiflora auriculata and *P. cispnana* were collected during the execution of project Flora do Maranhão during the year of 2016. Both species were found in field expeditions conducted at Mirador State Park (southern Maranhão state), yet only *P. auriculata* was found in expeditions at Jalapão State Park (Tocantins state) in April of 2019. *Passiflora cispnana* was reported to Alagoas state based on photographs of voucher specimens deposited in the UFP herbarium at Federal University of Pernambuco. Specimens were collected following usual procedures in plant taxonomy (Fidalgo and Bononi 1989), and were then deposited in the herbarium at the Federal University of Maranhão, Codó Campus, and in the RBR herbarium at Federal Rural University of Rio de Janeiro. Species were identified using identification keys and specialized literature (Killip 1938; Milward-de-Azevedo et al. 2012; Boza et al. 2018; Milward-de-Azevedo 2019).

The known occurrence points and species distribution were based on: published material (Milward-de-Azevedo et al. 2012; Boza et al. 2018; Milward-de-Azevedo 2019); information obtained from labels of photographed voucher specimens, available at the speciesLink database (<http://splink.cria.org.br>) and Brazilian Flora Database–Jabot (<http://jabot.jbrj.gov.br/v2/consulta.php>); photos provided by the UFP and UPGB herbaria; and collections of *Passiflora* consulted in the herbarium MG.

Species distribution maps were obtained using software QGIS 2.18 Las Palmas. We carried out a regional assessment of the conservation status of both *Passiflora auriculata* and *P. cispnana*, with focus in Brazil. For this assessment, the area of occupancy (AOO) and extent of occurrence (EOO) were calculated using the Geospatial Conservation Assessment Tool (GeoCAT; <http://geocat.kew.org>). The AOO was based on a defined cell width of 2 km. To estimate the geographical distribution of *P. auriculata* and *P. cispnana* in Brazil and to verify the approximation of the reference values of AOO and EOO, we used

geographical occurrences present in the online database speciesLink (2019). We included the two new geographical occurrences of *P. auriculata* for a total of 162 and the three new ones of *P. cispnana* for a total of 54 occurrences. The regional risk assessments followed the IUCN Red List Categories and Criteria (2012) in conjunction with the Guidelines for Application of the IUCN Red List Criteria at Regional and National Levels, version 4 (2010).

Results

***Passiflora auriculata* Kunth**, Nov. Gen. Sp. 2: 131. 1817

Figure 1A–E

New records. Brazil: Maranhão: Mirador, Mirador State Park (06°31'24"S, 045°28'43"W), 07.II.2016, E.O. Silva and A.W.C. Ferreira 27 (UFMA). Tocantins: Mateiros, Jalapão State Park, Velha Waterfall (10°16'12"S, 046°52'53"W), 21-IV-2019, M. Milward-de-Azevedo 563 (RBR).

Additional examined material: Amazonas: Cucui, alto Rio Negro, 4.V.1975, P. Cavalcante 3108 (MG). Acre: Cruzeiro do Sul, 9-II-1976, O. P. Monteiro and C. Damião 234 (MG). Pará: IPEAN, Mocambo Reserve (01°26'26"S, 048°24'40"W), 10-V-1968, J. M. Pires and N. T. Silva 11698 (IAN); Goianésia do Pará, 10-IV-2003, L.C.B. Lobato and O.C. Nascimento 2993 (MG).

Description. Climbing vine. Stem subterete, striate, green, pubescent. Tendrils simple, well-developed. Stipules 0.5–0.8 cm long, linear-subulate. Petioles 1.3–5 cm long, with one pair of auriculate glands at the lower half. Leaves unlobed (rarely) to slightly 3-lobed, distance between lobes 8 cm, lateral lobes 2.5–9 cm long, midrib 2.5–8 cm long, lobes forming at the leaf upper third, apex acute, base obtuse or rounded, margin entire, ocelli present on the abaxial surface. Flowers with corona biseriate with filiform filaments, ovary ellipsoid, tomentose. Fruit 1–1.5 × 1–2 cm, globose, tomentose. Seeds ca 3.5 × 2.5 mm, obovate, with five to seven transverse grooves.

***Passiflora cispnana* Harms**, Bot. Jahrb. Syst. 18 (Beibl. 46): 5. 1894

Figure 2A–C

New records. Maranhão: Formosa da Serra Negra: entrance of the Mirador State Park (06°43'13"S, 045°53'55"W), 06-II-2016, E.O. Silva and A.W.C. Ferreira 26 (UFMA). Alagoas: Grande-Varjão Mountain Range, Coimbra Forest, Coimbra, 13-III-2007, L. Coe and O. Cruz 01 (UFP); Ibateguara: Varjão-Coimbra Grotto (08°58'21.0"S, 035°56'21.8"W), 18-III-2002, M. Oliveira 824 (UFP).

Additional examined material. Minas Gerais: Bandejas (15°49'30.8"S, 040°31'20.8"W), 30-I-2004, W.W. Thomas et al. 13689 (NY). Rio de Janeiro: Rio de Janeiro (22°54'S, 043°12'W), J.F. Widgren 117 (S, UPS). Pará: Altamira: Cachimbo Mountain Range, XII-2005, M. Sobral & A.G. Oliveira 10.825 (UPCB).



Figure 1. *Passiflora auriculata*. **A.** Leaf slightly 3-lobed. **B.** Leaf simple. **C.** Ocelli on abaxial surface. **D.** Petiole with one pair of auriculate glands. **E.** Seeds with transversal grooves. Scale bar = 1 mm. Photographs by EO Silva.

Description. Climbing vine. Stem subangular, slightly pubescent. Tendrils simple, well-developed. Stipules 0.3–0.5 cm long, linear-subulate to falcate. Petioles 0.8–3 cm long, glands absent. Leaves two-lobed, distance between lobes 4–13 cm, lateral lobes 3–10 cm long, midrib 2–6 cm long, apex of lateral lobes acuminate, central lobe, when present with apex obtuse, base cordate, margin entire, ocelli absent. Flowers not observed. Fruit 1–2.5 × 0.5–1.4 cm, subglobose to ellipsoid or obovoid, hirsute, reddish. Seeds ca 2.5 × 1.7 mm, obovate, with or without distinct projection, with five or six transverse grooves.

Key to *Passiflora auriculata*, *P. cisanana*, and species allied to *P. cisanana*

(Modified from Milward-de-Azevedo et al. 2012; Boza et al. 2018)

- 1. Petioles with glands, ocelli present *P. auriculata*
- 1'. Petioles without glands; ocelli absent 2

- 2. Corona uniseriate, filaments liguliform ... *P. cervii*
- 2'. Corona 1-2-seriate, filaments filiform 3
- 3. Corona length between sepals and petals or as long as the petals *P. rubra*
- 3'. Corona shorter than petals or in between sepals and petals 4
- 4. Fruit fusiform, seeds with a large projection *P. capsularis*
- 4'. Fruit subglobose to obovoid, seeds with or without distinct projection *P. cisanana*

Discussion

A particular feature in *Passiflora auriculata* is having its leaves ranging from entire to slightly three-lobed, and such variation is commonly found in a same individual (Killip 1938; Milward-de-Azevedo et al. 2012; Silva et al. 2013; Milward-de-Azevedo 2019).

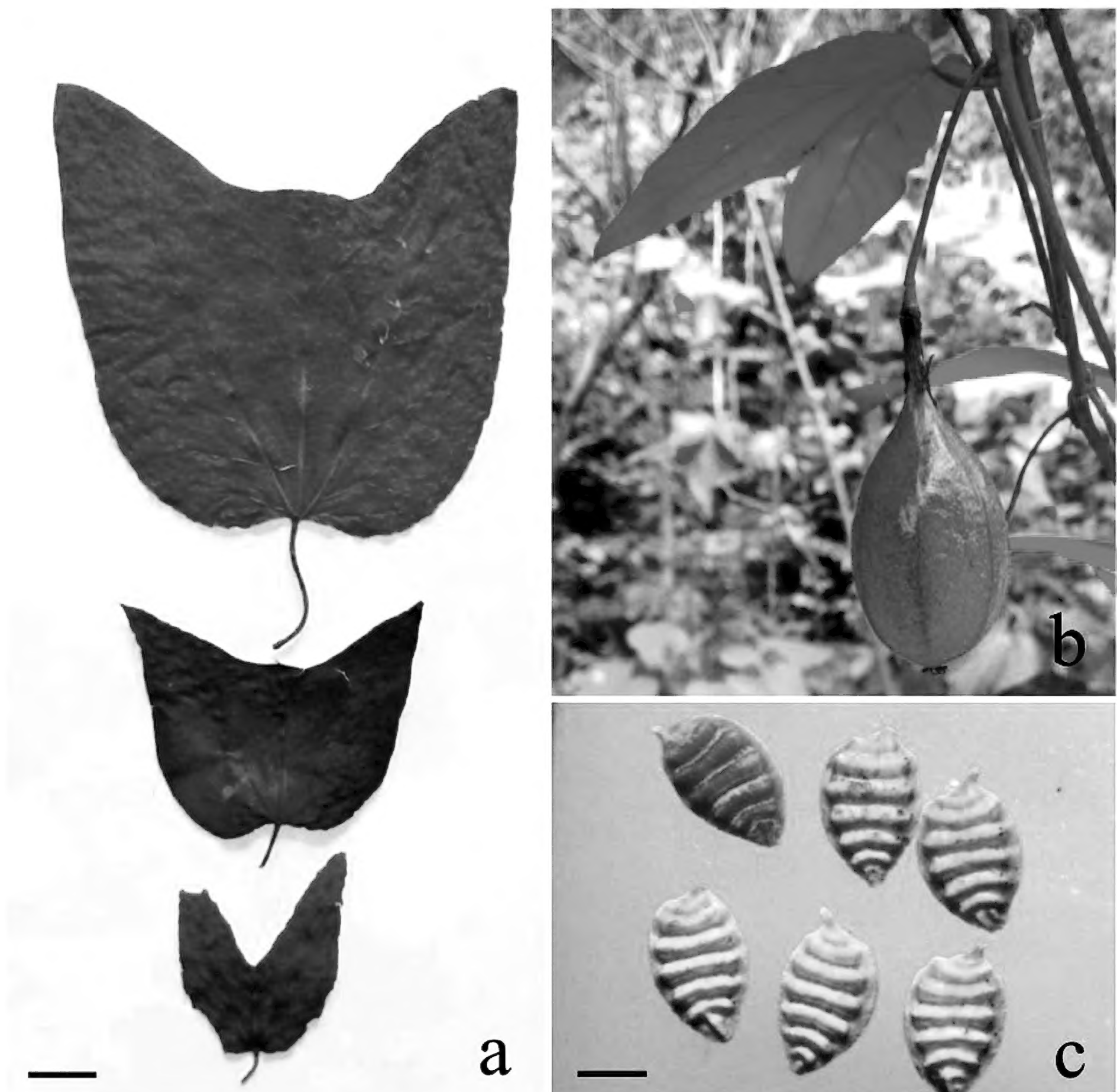


Figure 2. *Passiflora cispiana* **A.** Leaves: morphological variations. **B.** Fruit **C.** Seeds. Scale bar = 1 cm (A), 1 mm (C). Photographs by EO Silva.

Passiflora auriculata occurs in Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guyana, Nicaragua, Panama, Peru, Suriname, Trinidad, and Venezuela. In Brazil, the species occurs in the states of Acre, Amapá, Amazonas, Espírito Santo, Maranhão, Mato Grosso, Minas Gerais, Pará, Rio de Janeiro, Rio Grande do Norte, Rondônia, and Roraima (Fig. 3). Having neotropical distribution, *P. auriculata* occurs from the Andean forests, mountain ranges covered by tropical forests, and lowland forests to the typical savanna vegetation (Milward-de-Azevedo 2019).

The material collected of *P. auriculata* (E.O. Silva & A.W.C. Ferreira 27 (UFMA)) represents a rediscovery of the species, as it takes place eight decades after the first collection was made in the state (R. Froés, n. 11741, 1939) (Fig. 4), but only recently reported by Milward-de-Azevedo (2019). The rediscovery in our study (Fig. 1) also represents an expansion of the species distribution

area to approximately 480 km south of the nearest known collection site in the state. Additionally, we report here, for the first time, the species occurrence in Tocantins state (M. Milward-de-Azevedo 563 (RBR)), thereby also expanding the species distribution area in the Brazilian northern region (Fig. 3).

The estimated EOO of the species in Brazilian territory is 7,527,550 km², while its estimated AOO is 336 km². Adopting the random-walk method (Filgueiras et al. 1994) at Mirador State Park (southern Maranhão state), we found, only once, few individuals of *P. auriculata*, sparsely distributed in the interior of a Cerrado forest, near roads, plantations, and sites susceptible to deforestation as well to other anthropic actions. As indicated above, *P. auriculata* has a very wide distribution, with high EOO but a small AOO, hence meets the criteria for being Endangered. However, the taxon is relatively common outside Brazil and has a broad global distribution,

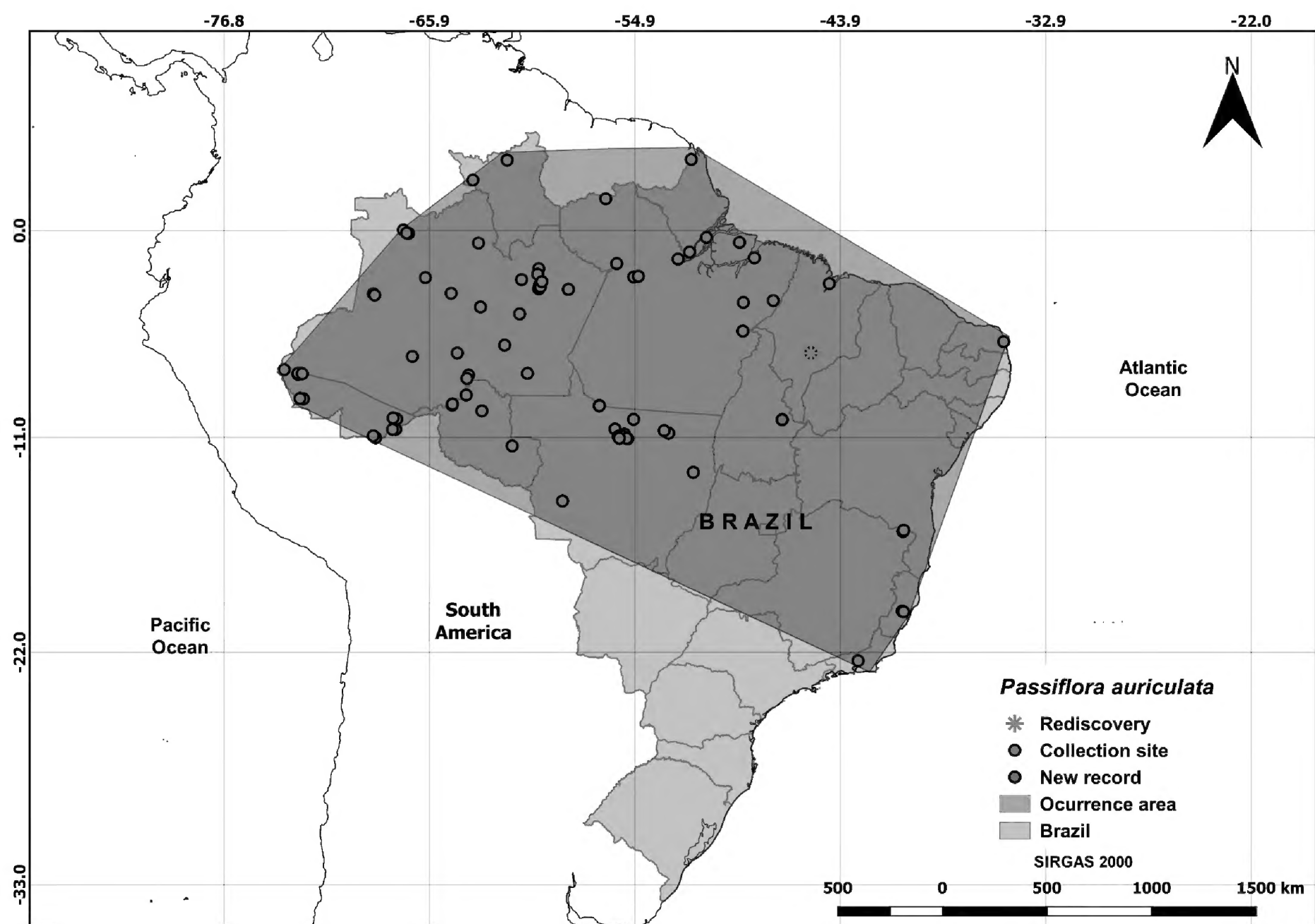


Figure 3. Geographic distribution of *Passiflora auriculata* in Brazilian territory.

thus it is assumed that subpopulations reinforce each other by possible interactions with populations outside that region, and consequently increase the long-term survival of the species (Gärdenfors et al. 2001). Therefore, following the criteria established by the International Union for Conservation of Nature (IUCN 2012) and the recommendations by the IUCN Red List Criteria at Regional and National Levels (2010), *P. auriculata* can be considered at the category of Least Concern (LC).

Passiflora cissana is notable because the leaves of this species lack ocelli. Another feature is the densely hirsute fruit with reddish color (Killip 1938; Milward-de-Azevedo et al. 2012). *Passiflora cissana* might be mistaken for *P. capsularis* L., *P. cervi* Milward-de-Azevedo and *P. rubra* L., yet it differs from them in the following morphological features: ovary ellipsoid to obovoid, densely hirsute; fruit subglobose, ellipsoid or obovoid with base abruptly attenuated, the seeds either with no distinct projection or, when present, smaller than 0.4 mm (Boza et al. 2018). *Passiflora cissana* also differs from the other three species in its geographic distribution.

Passiflora cissana occurs in Brazil, Bolivia, Colombia, Ecuador, French Guiana, Guyana, Peru, and Venezuela. In Brazil, *P. cissana* occurs in the states of Bahia, Ceará, Maranhão, Pará, Pernambuco, and Tocantins (Fig. 5). The species is found in ombrophilous forests, savannas, vegetation under influence of marine environments, upper-montane forests, near rivers and waterfalls,

roadsides, and in Restinga vegetation (Milward-de-Azevedo et al. 2012).

In this study, we present the second report of occurrence of the species in Maranhão state (E.O. Silva & A.W.C. Ferreira 26 (UFMA)). Such report constitutes a rediscovery of *P. cissana*, as it takes place four decades after the first collection of the species was made in the state (Fig. 6). The present report also represents an expansion of the species distribution area to approximately 328 km south of the nearest known collection site. Additionally, our report expands the species distribution area in the Brazilian northeastern region, as we confirm here the species occurrence in Alagoas state (Fig. 5).

Boza et al. (2018) conducted a principal component analysis on the *P. rubra* L. species complex and recognized two species: *P. cissana*, distributed across South America, and *P. rubra* L., distributed in Caribbean islands.

Boza et al. (2018) reported the occurrence of *P. cissana* in the Brazilian states of Minas Gerais and Rio de Janeiro (southeastern Brazil). The species occurs in the north and northeastern regions of the country, and the specimens based on which these reports were made (i.e. from Minas Gerais: W.W. Thomas et al. 13689 (NY) and from Rio de Janeiro: J.F. Widgren 117 (S, UPS) are identified here as *P. cervi* Milward-de-Azevedo and *P. capsularis* L., respectively. Boza et al. (2018) also reported the occurrence of *P. cervi* Milward-de-Azevedo in the

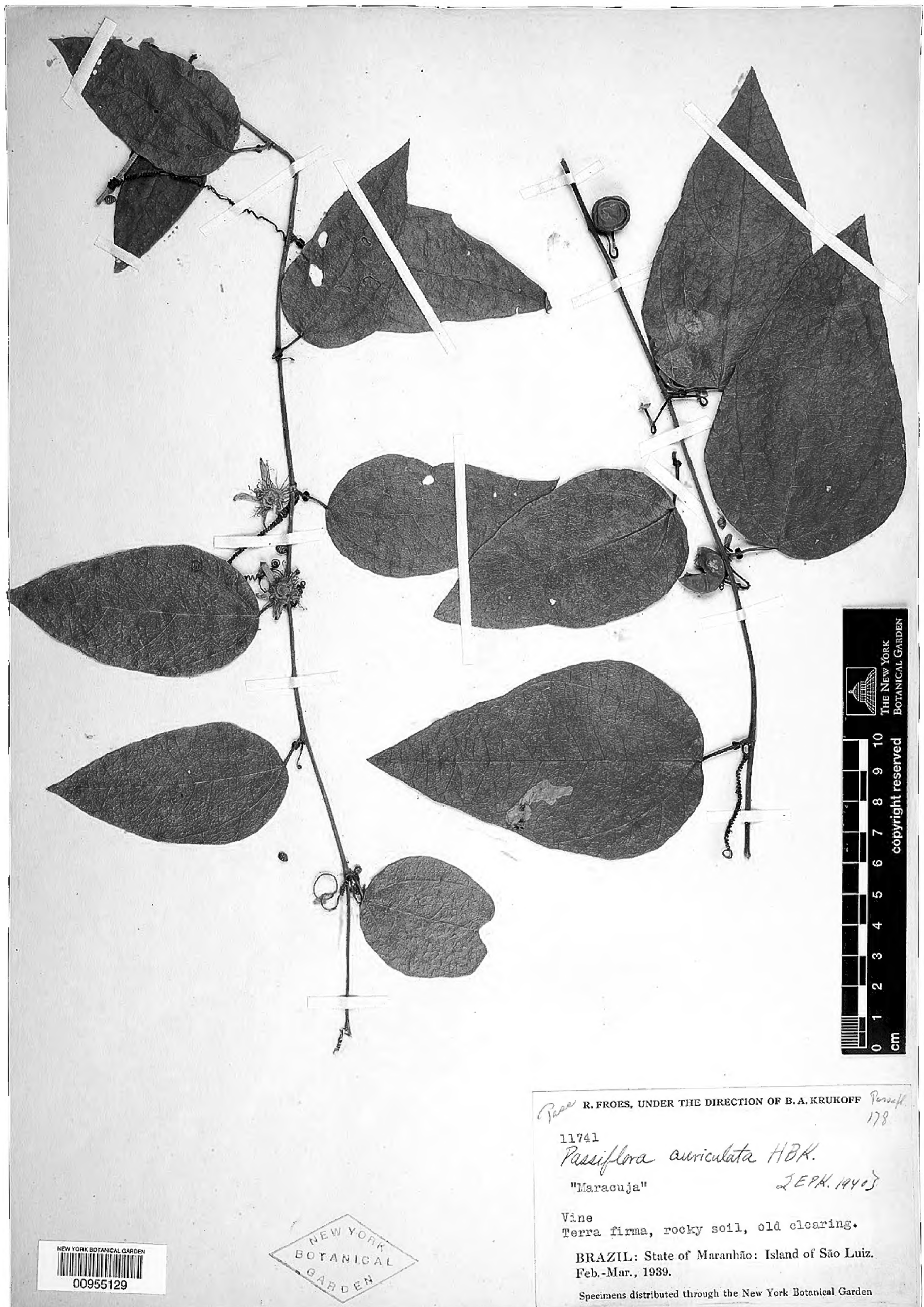


Figure 4. Herborized specimen of *Passiflora auriculata*.

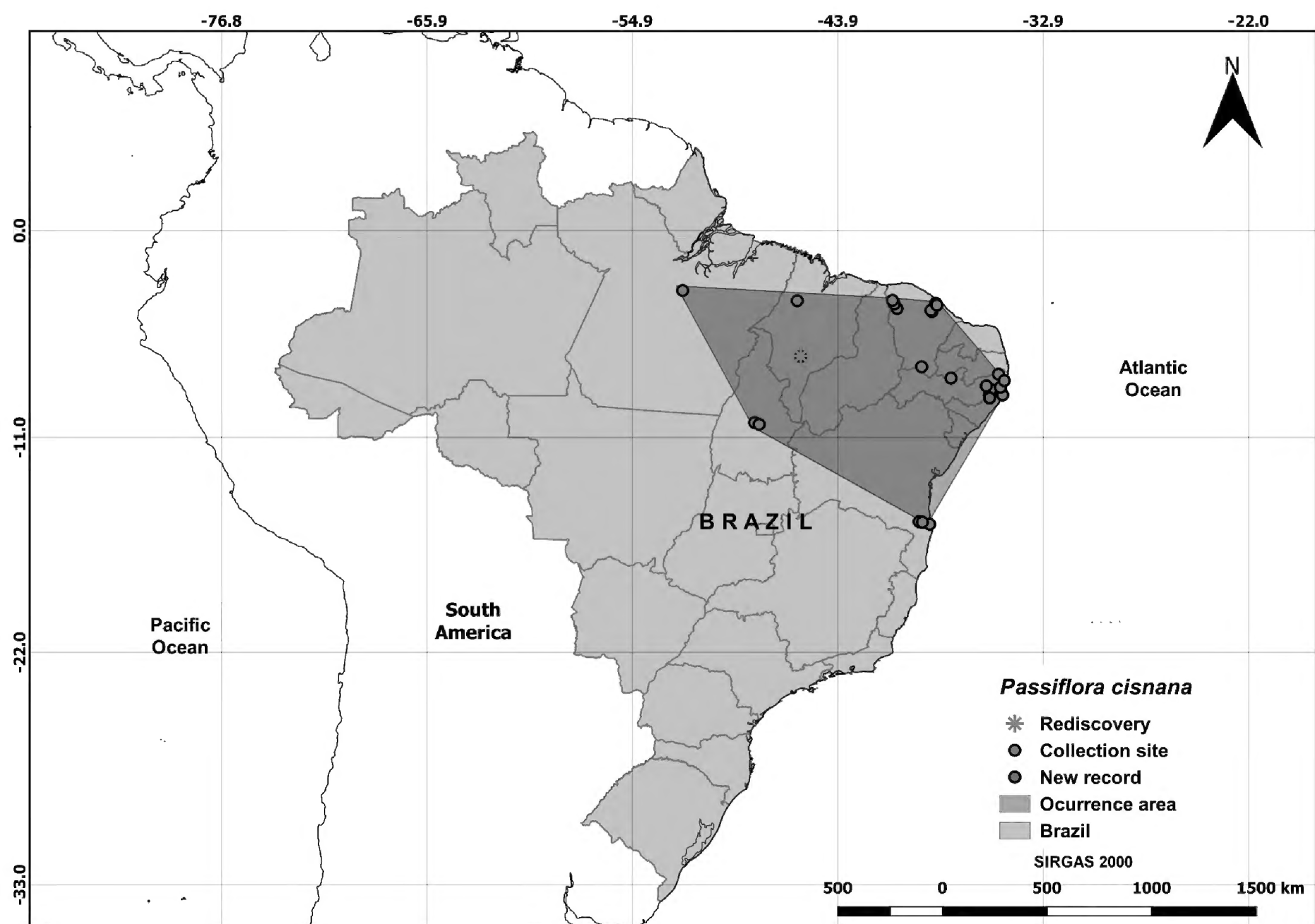


Figure 5. Geographic distribution of *Passiflora cispnana* in Brazilian territory.

Carajás Mountain Range in Pará state, northern Brazil; however, here we identify that material as *P. cispnana*. Furthermore, the geographic distribution of *P. cervii* is restricted to the Brazilian south and southeastern regions. Milward-de-Azevedo et al. (2012) added Pará state to the species map of occurrence, but the authors failed to include such information on the description of the species distribution and examined material (Pará, Altamira, Cachimbo Mountain Range, 12/2005, M. Sobral 10.825 (UPCB)).

During field trips taken at Mirador State Park (southern Maranhão state), we found several populations of the species, with fertile individuals, always occurring alongside roads at the edges of dense forest formations. The species estimated EOO and AOO are 1,543,378 km² and 112 km², respectively. Similar to the previous species, *P. cispnana* has broad global distribution, although having a quite low estimated AOO (<500 km²; IUCN 2012) in Brazilian territory. The regional population of *P. cispnana* within the polygonal region formed by EOO (Fig. 5) is separated by large distances from occurrences related to neighboring countries, where the species also generally occurs, but does not appear to be isolated from these other populations in South America, where the species is registered. Although there is no direct evidence about contact with these neighboring populations, this is a widespread species in the American continent, and is likely that, as suggested by Gärdenfors et al. (2001), the immigration from outside the region will tend to reduce

the risk of regional extinction. Therefore *P. cispnana* is here assessed as of Least Concern (LC).

Currently, 23 Passifloraceae species are reported to occur in Maranhão state, 11 occurring in Tocantins, and 14 in Alagoas (Flora do Brasil 2020). These numbers may be considered low in view of the ones reported for other Brazilian states that include in their territories phytogeographic domains such as the Amazon and the Atlantic Forest. At Maranhão state, new records of *Passiflora* species have been reported, namely: *Passiflora pedata* L. (Silva et al. 2016); *P. mansoi* (Mart.) Mast. (Mezzonato-Pires et al. 2017); *P. cincinnata* Mast., *P. picturata* Ker Gawl., *P. vespertilio* L. (Silva et al. 2018); and *P. auriculata* (Milward-de-Azevedo 2019). This increase in the list of species for the state of Maranhão may be justified by the recent explorations to the various diverse habitats that characterizes the state, such as the transition area between the Amazonian and the semi-arid climate, which houses a diversity of environments (cerrados, formations of babassu-palm, and dense forests) (Silva et al., 2018). With this study, we contributed to increase the knowledge on *Passiflora* species from Maranhão state, with two new rediscoveries therein, and to expand the number of occurrences of *Passiflora* species in Alagoas and Tocantins, for a total of 15 and 12 species reported to those states, respectively. However, further floristic surveys remain necessary in states from the Amazon and Atlantic Forest domains, such as Tocantins and Alagoas.

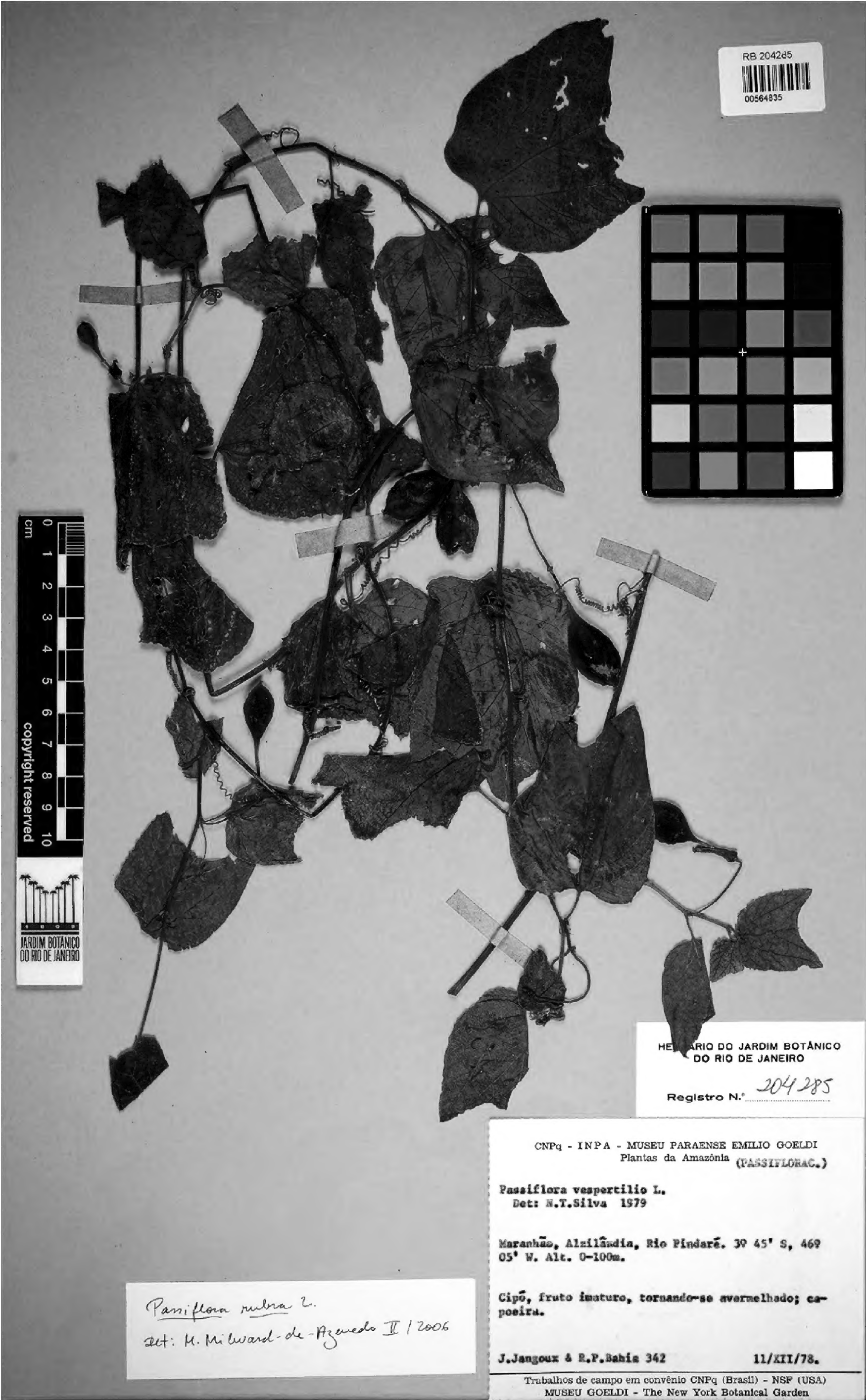


Figure 6. Herborized specimen of *Passiflora cissana*.

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Author contributions

EOS, AWCF, MAMDA collected the specimens; EOS, MAMDA, identified the specimens, revised herbarium collections and wrote the text; AWCF, MEGS revised the text; MEGS guided the first author's doctorate.

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Appendix

Material used for figures. *Passiflora auriculata*. Brazil: Maranhão: Mirador, Mirador State Park (06°31'24"S, 045°28'43"W), 07.II.2016, E.O. Silva & A.W.C. Ferreira 27 (UFMA), Figure 1A–C; São Luís (02°31'47"S, 044°18'10"W), II/III-1939, R.L. Fróes 11741 (RB). Pará: IPEAN, Mocambo Reserve (01°26'26"S, 048°24'40"W), 10-V-1968, J. M. Pires & N. T. Silva 11698 (IAN), Figure 1D and E; Goianésia do Pará, 10-IV-2003, L.C.B. Lobato & O.C. Nascimento 2993 (MG); *Passiflora cisanana*. Maranhão: Formosa da Serra Negra: entrance of the Mirador State Park (06°43'13"S, 045°53'55"W), 06-II-2016, E.O. Silva & A.W.C. Ferreira 26, (UFMA); Formosa da Serra Negra: entrance of the Mirador State Park (06°43'13"S, 045°53'55"W), 07-II-2016, E.O. Silva & A.W.C. Ferreira 28, (UFMA), Figure 1A–C; Alzilândia, 11-XII-1973, J. Jangoux et R.P. Bahia 342 (RB).